WEB-BASED TOOLS FOR THE ANALYSIS OF TAOS DATA AND MUCH MORE

D. Ricci[1], P.-G. Sprimont[2], C. Ayala[1], F. G. Ramón-Fox[1], R. Michel[1], S. Navarro[1], S.-Y. Wang[3], Z.-W. Zhang[3], M. J. Lehner[3], L. Nicastro[2], M. Reyes-Ruiz[1]

RESUMEN

Sugerimos un nuevo enfoque basado en las tecnología web para navegar y visualizar datos producidos por una red de telescopios, tales como los del projecto TAOS en curso y del projecto TAOS II de próxima realización. Proponemos una moderna tecnología "lado cliente" y presentamos dos ejemplos basados en dos programas desarrollados para diferentes tipos de acceso "lado servidor" a la base de datos. El software se programó para fines astronómicos genéricos, y fue aplicado específicamente en los ejemplos para la inspección de las curvas de luz de TAOS.

ABSTRACT

We suggest a new web-based approach for browsing and visualizing data produced by a network of telescopes, such as those of the ongoing TAOS and the forthcoming TAOS II projects. We propose a modern client-side technology and we present two examples based on two software packages developed for different kinds of server-side database approaches. In spite our examples are specific for the browsing of TAOS light curves, the software is coded in a way to be suitable for the use in several types of astronomical projects.

Key Words: Stars: Variables — Techniques: Photometric — Methods: Data Analysis — Astronomical Data Bases: Miscellaneous — Astronomical Data Bases: Virtual Observatory Tools

1. GENERAL

Modern astronomical observatories obtain every night a large amount of information every night, and this is even more true in the case of pre-scheduled or automatic surveys, such as those implemented for robotic telescopes. These data are then typically stored in web-accessible databases. One example of these robotic observations is represented by TAOS II (Transneptunian Automated Occultation Survey), a project aimed at measuring the size distribution of small objects in the Kuiper Belt and beyond[4]. The produced data will be automatically processed to output light curves for more than 10 000 stars at a high rate (20Hz). This survey will improve the previous TAOS project (Taiwan American Occultation Survey), which already provided a large amount of data (Zhang et al. 2013). How to keep trace and, when necessary, visually inspect such a huge amount of data? It is crucial to have a tool that can efficiently access and browse the database and then display graphically the selected data. Modern web 2.0 tools provide the perfect solution because they allow to build extremely user-friendly interfaces to achieve this task in a graphical and intuitive way, while preserving a scientific approach. Moreover, the concept can be applied to different kind of archives. In the Internet era, the most easy way to filter and browse a huge amount of information is indeed a web browser.

2. CLIENT-SIDE IMPLEMENTATION

We suggest to build this kind of new web-based astronomical applications by using the most recent client-side HTML5 technologies, following the pattern of educational examples already realized to test the methodology (Ricci & Nicastro 2013; Ricci et al. 2013). Among them the new `<canvas>` tag is noticeable for its possible use in tools like a FITS file inspectors. In fact it would be able to display and manipulate PNG-tiles (like those used for ground maps), or 3-d graphs through the use of `webgl`. We also suggest the use of vector graphics by embedding objects in `<svg>` tags. For a true and more advanced user-client and client-server interaction, `javascript` is commonly used; the `jquery` library for ajax calls and the `d3.js` library[5] for data-driven manipulations of the DOM (Bostock et al. 2011) were successfully tested and recommended to this aim.

[1]Instituto de Astronomía, UNAM, Campus Ensenada, 22860 Ensenada, B.C., México (indy@astrosen.unam.mx).

[2]INAF, Istituto di Astrofisica Spaziale e Fisica Cosmica di Bologna, via P. Gobetti, 101, 40129 Bologna, Italy.

[3]ASIAA, 11F of Astronomy-Mathematics Building, AS/NTU. No.1, Sec. 4, Roosevelt Rd, Taipei 10617, Taiwan, R.O.C.

[4]`http://taos2.asiaa.sinica.edu.tw/`

[5]See `http://jquery.com/` and `http://d3js.org/`

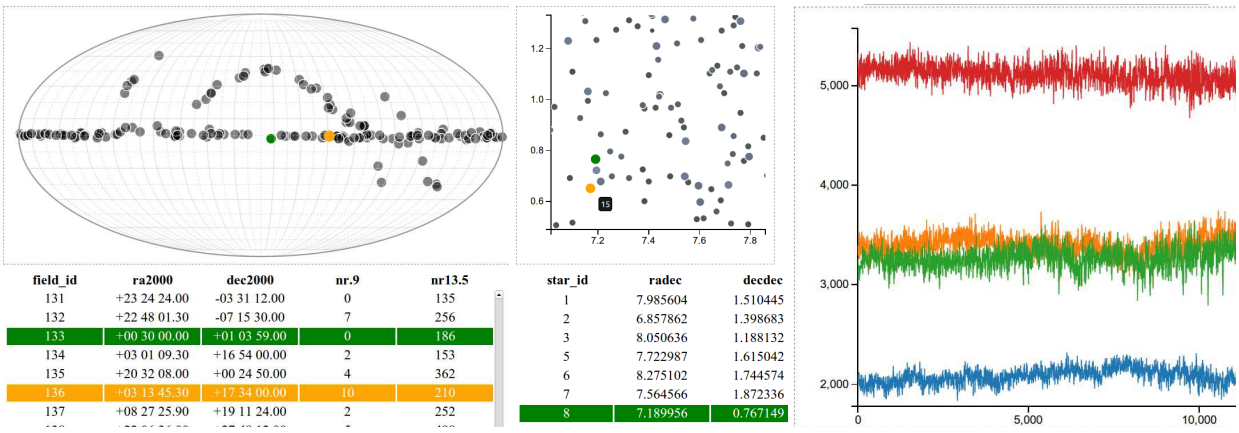

Fig. 1. Example of Web2.0 approach. LEFT: page with the map of TAOS fields; CENTER: stars of a selected field (the axes represent celestial coordinates); RIGHT: light curves of a selected star observerd by 4 telescopes (the x and y axes represent points and counts, respectively). Colored Selections for clicked and mouseover elements are also shown. The plots were populated by querying a `mysql` database using "`decibel`" (see the text), and rendered in `<svg>` using `d3`.

3. SERVER-SIDE TECHNOLOGIES AND EXAMPLES

Once the server side call is done, the data can be retrieved from a database and pre-treated using server-side technologies. We propose here two possible approaches. The first is the traditional LAMP architecture: server-side Linux machine with an Apache web server, `MySQL` database management system, and `PHP` as server-side scripting language, with the inclusion of the `mysqli` module for the creation of object oriented interfaces. In this framework, we implemented "`decibel`", a mysql-wrapper specifically meant for astronomical databases[6]. We used it to visualize[7] the TAOS observed fields (see Fig. 1) in the framework of a preliminary data reduction also presented in **these Proceedings (Ricci et al.)** Eventual `c++` applications for data reduction can be called in `Php` using the `exec()` command as true external programs. The second, modern approach is based on the new concept of SSE (Server Sent Events), and implemented using `Node.js`, a solution which makes use of javascript also as server-side language to build a web server and associated services. In this case, the `c++` applications can be fully compiled as `Node.js` modules and integrated in "addons". As an alternative to `MySQL`, it is possible to use non-relational databases such as `MongoDB`, excellent to manage tree-structured data. The advantage of this database is that the structure and the output is in `json` format, which is light and easy to handle in javascript. Following this path, we contributed to the development of the software "`sadira`", a database system and web GUI for astronomical data storage[8], also presented in **these Proceedings (Sprimont et al.)**, in the framework of the GLORIA (GLObal Robotic-telescopes Intelligent Array) project[9]. A test with a TAOS file containing the light curve and other data stored in the FITS binary tables is visible in the "*Experiments*" section of the sadira demo site.

4. DEVELOPMENT & APPLICATIONS

The two presented solutions and the developed software ("`decibel`" and "`sadira`") are being developed in parallel to provide a complementary set of tools. The goal is to provide an easy way to inspect the database of TAOS light curves and in general any kind of astronomical database, such as, for example, a traditional set of images in FITS format, or an archive of raw or reduced spectra.

REFERENCES

Bostock, M., Ogievetsky, V., & Heer, J. 2011, Visualization and Computer Graphics, IEEE Transactions on, 17, 2301 [LINK]

Ricci, D. & Nicastro, L. 2013, in EAS Publications Series, Vol. 61, EAS Publications Series (Castro-Tirado, A. J. and Gorosabel, J. and Park, I. H.), 263–265

Ricci, D., Nicastro, L., & Pio, M. 2013, in INTED2013 Proceedings, 7th International Technology, Education and Development Conference (IATED), 2998–3007

Zhang, Z.-W., Lehner, M. J., Wang, & et al. 2013, AJ, 146, 14

[6] `http://ross.iasfbo.inaf.it/~gloria/decibel-class/`
[7] `http://sadira.iasfbo.inaf.it/~indy/taos-fields/taosfields.html`
[8] `http://sadira.iasfbo.inaf.it/`
[9] `http://gloria-project.eu`